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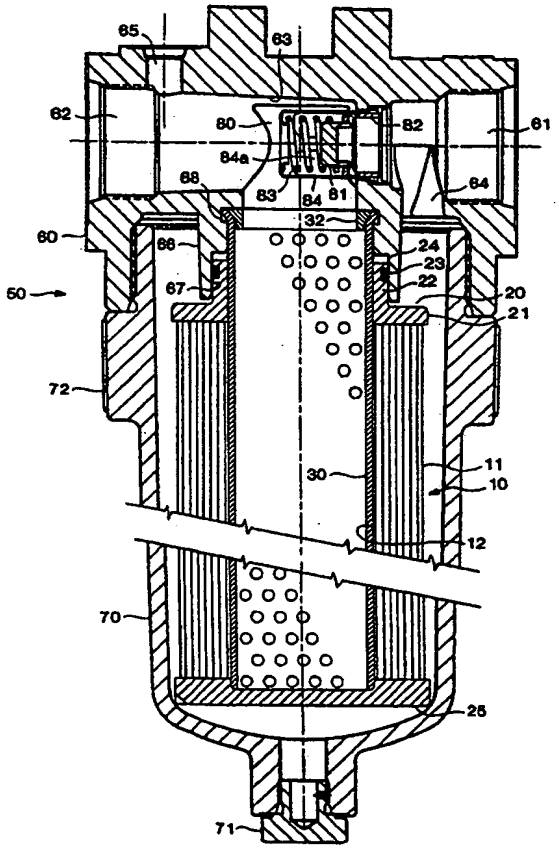
(54) Title: FILTER CARTRIDGE AND FILTER ARRANGEMENT

(57) Abstract

A filter cartridge (10) capable of being used with a detachable core (30) Includes a filter body (11) having a bore (12) and an end cap (20) sealed to an end of the filter body (11) and communicating with the bore (12). The end cap (20) including a sealing surface (24) on its exterior against which a seal can be formed. A sealing member, such as a sealing ring (23), can be mounted on the sealing surface (24) of the end cap (20). The bore (12) in the filter body (11) can detachably receive a core (30) for supporting the filter body (11). The core (30), which may be secured to the housing (50) or other member, need not be sealed to either the filter cartridge (10) or the housing (50).



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FILTER CARTRIDGE AND FILTER ARRANGEMENT

Background of the Invention

1. Field of the Invention

This invention relates to a filter cartridge capable of being used with a detachable core and to a filter arrangement using such a filter cartridge.

2. Description of the Related Art

Many filter cartridges are equipped with an internal support member, generally referred to as a core, for increasing the physical strength of the filter cartridge. The core can serve a variety of functions. It can provide the filter cartridge with resistance against axial, bending, or torsional loads, and it can prevent the filter cartridge from collapsing inwardly under radially inward forces when the fluid pressure is greater on the exterior than on the interior of the filter cartridge. The core can also be used as a structure for connecting the filter cartridge to other members, such as a tube sheet or fitting within a housing.

In many filter cartridges, the core is permanently attached to other portions of the filter cartridge, such as to end caps of the filter cartridge. However, when the filter medium employed in the filter cartridge is intended to be discarded when it becomes loaded with contaminants, it is advantageous to form the filter cartridge such that the core is readily detachable from the remainder of the filter cartridge, enabling the core to be reused as part of another filter cartridge or separately disposed. Making the core detachable from the remainder of the filter cartridge not only decreases waste when the remainder of the filter cartridge is discarded, but it enables the filter cartridge to be manufactured more economically and decreases the weight of the filter cartridge. For strength purposes, it is frequently desirable to make the core of a filter cartridge of metal even though other portions of the filter cartridge may be nonmetallic. If a metal core is a permanent part of a filter cartridge, it may be impossible to dispose of the filter cartridge by incineration. On the other hand, if a metal core is detachable from a filter cartridge, the nonmetallic components of the filter cartridge may be disposed of by incineration while the metal core is reused,

providing a significant decrease in the cost of disposing of the used filter cartridge.

Summary of the Invention

The present invention provides a filter cartridge which is simple in structure and economical to manufacture and which is without a permanent core but which is capable of being used with a detachable core.

The present invention also provides a filter arrangement employing such a filter cartridge.

The term "filter cartridge" refers to a device including a filter medium which can be installed as a pre-assembled, replaceable unit in a filter housing or other part of a fluid handling system. A filter cartridge according to the present invention will generally not include a core as a permanent part of the filter cartridge, but preferably it is possible to employ the filter cartridge with a detachable core formed separately from the filter cartridge.

According to one form of the present invention, a filter cartridge includes a filter body having first and second ends, the filter body containing a filter medium and having a bore for receiving a core extending to the first end of the filter body, and a first end cap adjoining the first end of the filter body. The exterior surface of the first end cap has a sealing surface against which a seal to seal the first end cap to a portion of a fluid system. In a preferred embodiment, the filter cartridge includes a sealing member mounted on the sealing surface for sealing against a filter housing. The filter cartridge may also include a second end cap adjoining the second end of the filter body.

According to another form of the present invention, a filter arrangement includes a filter cartridge disposed in a housing. The filter cartridge includes a filter body having first and second ends and a first end cap adjoining the first end of the filter body. A core for transporting fluid between a bore formed in the filter body and an exterior of the filter cartridge is removably disposed inside the bore of the filter body. The core may be secured to the housing so that the filter cartridge may be removed from the housing without removing the core. The core need not be sealed to either the housing or the filter cartridge. In a preferred embodiment, a seal is formed between the interior of the housing and an exterior surface of the first end cap.

According to yet another form of the present invention, a filter arrangement includes a filter body having a filter medium and a bore communicating with an end surface of the filter body. A first end cap adjoining the end surface of the filter body has a sealing surface on an exterior thereof against which a seal can be formed. A core is slidably received within the bore of the filter body and has an outer diameter enabling the core to pass in a lengthwise direction through a bore in the first end cap.

Because a seal between a filter cartridge according to the present invention and a portion of a filter housing or other component in a fluid system is formed on an exterior surface of a first end cap of the filter cartridge, the filter cartridge is economical to manufacture. For example, if the first end cap is a molded member, the sealing surface of the first end cap may comprise a groove for receiving a sealing ring formed on the exterior of the first end cap as part of the molding process. Therefore, costly procedures such as machining of the first end cap to form the sealing surface can be avoided.

A filter cartridge according to the present invention can be installed anywhere along a flow path of a fluid to be treated in a variety of fluid systems. For example, it can be installed in a housing, on the exterior of a conduit, or on a wall or other surface. It can be used for a variety of types of fluid processing, such as for filtration to remove solids from a fluid, for coalescing, for sparging, or for other purposes. The filter cartridge is not restricted to use with any particular fluid and can be used with liquids, gases, and multiphase mixtures, for example.

Brief Description of the Drawings

Figures 1 through 3 are cross-sectional elevations of different embodiments of filter arrangements according to the present invention.

Description of Preferred Embodiments

Figure 1 is a cross-sectional elevation of an embodiment of a filter arrangement employing a replaceable filter cartridge 10 according to the present invention. The filter cartridge 10 is shown disposed in a filter housing 50 surrounding a core 30 detachably connected to the housing 50. The housing 50 includes a head 60 to which the filter cartridge 10 is attached and a bowl 70 which surrounds the filter cartridge 10 and which is detachably connected to the head 60 to

enable the filter cartridge 10 to be installed and replaced.

The filter cartridge 10 includes a filter body 11 containing a filter medium, a first or upper end cap 20 disposed at one end of the filter body 11, and a second or lower end cap 25 disposed at the opposite end of the filter body 11.

While the filter cartridge 10 is shown vertically oriented in the figures with the upper end cap 20 disposed above the lower end cap 25, the filter cartridge 10 may have any desired orientation with respect to the vertical. For example, it may be horizontal, or it may be disposed with the first end cap 20 lower than the second end cap 25.

The flow path through the filter cartridge 10 during filtration is not restricted to any particular direction. For example, the flow path may extend in a radial direction of the filter cartridge 10 (either radially inwardly or outwardly), in an axial direction, or both radially and axially. In the illustrated embodiment, the fluid to be filtered normally flows radially inwardly through the filter cartridge 10 from the interior of the bowl 70 into the hollow core 30 at the center of the filter cartridge 10 and out of the housing 50 through the head 60 of the housing 50. Fluid may also pass through the filter cartridge 10 in the opposite direction from the normal flow direction, such as if the filter cartridge 10 is being cleaned by backwashing.

The filter body 11 is a hollow member containing a filter medium for performing a desired type of fluid treatment, such as removing selected materials from the fluid being filtered, coalescing, or sparging. The overall shape of the filter body 11 is not restricted. In the present embodiment, it has an overall cylindrical shape on both its inner periphery and its outer periphery, but the peripheries need not be cylindrical and need not be of the same shape. For example, one of the inner and outer peripheries may be cylindrical while the other of the peripheries is prismatic, i.e., polygonal in cross section. The transverse cross section of the filter body 11 may be constant or may vary over the length of the filter body 11. In the present embodiment, the filter body 11 has a centrally located cylindrical bore 12 which extends over the entire length of the filter body 11, but the bore 12 need not be at the center of the filter body 11 and it need not extend to the bottom end of the filter body 11. The diameter of the bore 12 may vary in accordance with the desired tightness of fit between the filter body 11 and the core 30. It may be desirable for the bore 12 to contact the outer surface of the core 30 around the entire circumference of the core

30 and over substantially the entire length of the filter body 11, since contact between the two surfaces can increase the life span of the filter body by preventing flexing of the filter body in response to pressure fluctuations which can weaken the filter body over time. In the present embodiment, there is an interference fit between the bore 12 and the core 30 to ensure contact between the opposing surfaces of the two members. However, there may instead be a loose fit between the core 30 and the bore 12, such as a clearance fit.

The structure of the filter body 11 is not restricted. For example, it may comprise a pleated structure with lengthwise or accordion pleats, it may be a non-pleated structure such as a bag filter or a fibrous tube, or it may comprise a plurality of sections having different structures. When the filter body 11 has lengthwise pleats, the pleats may extend substantially radially with respect to the longitudinal axis of the filter body 11, i.e., with the inner and outer ends of each pleat lying roughly on the same radius, or the pleats may be in a laid-over state in which the radially outer end of each pleat is displaced in the circumferential direction of the filter body 11 with respect to the radially inner end of the pleat as described, for example, in U.S. Patent No. 5,543,047.

The filter medium in the filter body 11 may be configured in a variety of ways. For example, it may be in the form of a mass of fibers, fibrous mats, woven or non-woven fibrous sheets, porous membranes such as supported or unsupported microporous membranes, porous foam, and porous metals or ceramics.

In addition to a filter medium, the filter body 11 may contain a variety of other components, such as drainage layers, diffusion layers, cushioning layers for reducing abrasion of the filter medium, an outer wrap member or sleeve disposed on the outer periphery of the filter body 11 to protect the filter medium, to increase the dirt capacity of the filter body 11, to reduce deformation of the filter body 11 during pressure fluctuations, to act as a prefilter or support for a filter cake, or to serve other purposes. A preferred example of a wrap member is a strip of material helically wrapped around the filter body in a plurality of turns with gaps between adjoining turns as described, for example, in U.S. Patent No. 5,252,207. When the filter body has lengthwise pleats, the wrap member may be joined to the peaks of the pleats to restrain movement of the pleats during pressure fluctuations. The filter body 11 may also include internal support members, such as an inner liner or an auxiliary

core which is less substantial than the primary core 30 for supporting the filter body 11 during its manufacture or handling.

The upper end cap 20 disposed at the end of the filter body 11 adjoining the head 60 of the housing 50 is an open end cap having a bore through which fluid can flow between the head 60 and the interior of the filter body 11. This end cap 20 may serve a variety of functions. It can be used to seal off the upper end of the filter body 11, to physically protect the upper end of the filter body 11, or to immobilize the upper end of the filter body 11 against shifting in response to fluctuations in fluid pressure. In addition, it seals the filter cartridge 10 to the head 60 of the housing 50 so that fluid can flow into the head 60 only by passing through the filter body 11.

The illustrated upper end cap 20 includes a generally disc-shaped base 21 which covers the upper end surface of the filter body 11 and a hollow neck 22 extending outwards from the base 21 and communicating with the interior of the filter body 11. The neck 22 may have any desired cross-sectional shape that enables it to be connected to the head 60 of the housing 50. Frequently, for ease of manufacture, it will have a circular transverse cross section.

The base 21 will typically be sealed to the upper end surface of the filter body 11 to prevent unfiltered fluid from bypassing the filter body 11. A seal may be formed in any manner suited to the materials of which the upper end cap 20 and the filter body 11 are formed. For example, sealing may be performed by physically joining the upper end cap 20 to the filter body 11 by a method such as adhesive bonding, spin welding, melt sealing, or welding. Alternatively, a seal may be formed by a sealing member, such as a gasket, sandwiched between the upper end surface of the filter body 11 and the upper end cap 20 and possibly joined to one or both of the filter body 11 and the upper end cap 20.

The upper end cap 20 may fit around the core 30 with any desired degree of tightness, ranging from a clearance fit to an interference fit. As the upper end cap 20 does not need to be sealed against the core 30, it may be convenient if there is a clearance fit between the upper end cap 20 and the core 30 to enable the core 30 to easily pass through the upper end cap 20. The upper end cap 20 is illustrated as having a constant inner diameter, but the inner diameter may vary over the length of the end cap 20. For example, the region of the end cap 20 adjoining the filter body 11 may have a somewhat smaller diameter than the region spaced from the filter body

11, thereby reducing manufacturing costs of the end cap 20 because the region spaced from the filter body 11 can have looser tolerances than the region of smaller diameter. Because there is an interference fit between the interior of the filter body 11 and the core 30 in the present embodiment, when the core 30 is withdrawn from the interior of the filter body 11 and the filter body 11 is in a relaxed state, the filter body 11 has an inner diameter which is smaller than the minimum inner diameter of the upper end cap 20.

The upper end cap 20 is sealed to the head 60 of the housing 50 along a sealing surface on the exterior of the upper end cap 20. If the upper end cap 20 is made of a sufficiently resilient material, a seal may be formed by direct contact between the upper end cap 20 and the head 60 of the housing 50. More typically, however, a seal will be achieved by one or more sealing members, such as O-rings, C-rings, or gaskets, formed separately from the upper end cap 20 and mounted on the sealing surface of the upper end cap 20. In the illustrated embodiment, the upper end cap 20 is equipped with a sealing member comprising an elastomeric O-ring 23 mounted in a circumferentially extending groove 24 formed in the exterior of the neck 22 of the upper end cap 20, with the interior of the groove 24 comprising a sealing surface and being sealed against the O-ring 23. Other possible locations for a sealing member are the outer periphery of the base 21 of the upper end cap 20 or on an axially-facing surface of the upper end cap 20. For example, the sealing member may comprise a gasket or a sealing ring mounted on the top surface of the base 21 of the upper end cap 20, and an axial force may be applied to the filter cartridge 10 to compress the sealing member against the surface of the head 60 opposing the base 21.

The seal produced by the sealing member between the upper end cap 20 and the housing 50 is of sufficient integrity to prevent substances large enough to be captured by the filter body 11 from flowing between the upper end cap 20 and the housing 50. Preferably, the sealing member provides a fluid-tight seal under the expected operating pressures of the filter arrangement.

Because of the seal between the exterior of the upper end cap 20 and the housing 50, it is unnecessary to form a seal between the upper end cap 20 and the core 30 or between the core 30 and the housing 50. This simplifies the structure of the filter arrangement.

Depending upon the loads acting on the filter cartridge 10, it may be desirable

to secure the upper end cap 20 to the head 60 to prevent the filter cartridge 10 from becoming detached from the head 60 due to its weight, vibrations, or fluid pressures acting in a direction to urge the filter cartridge 10 away from the head 60. For example, the upper end cap 20 may be secured to the head 60 by threads, a bayonet fit, a clamp, bolts, a snap fit, or frictional engagement. Alternatively, tie rods or a spring may maintain the filter cartridge 10 attached to the head 60. In the present embodiment, the length of the bowl 70 is such that the filter cartridge 10 cannot be detached from the head 60 when the bowl 70 is attached to the head 60. Therefore, in the present embodiment, the filter cartridge 10 is attached to the head 60 only by friction between the O-ring 23 and the head 60, and the weight of the filter cartridge 10 is supported by the head 60 of the housing 50 and/or by the bottom surface of the bowl 70.

The upper end cap 20 can be made of any material compatible with the fluid being filtered, including but not being limited to metals and polymers. The shape of the upper end cap 20 makes it particularly convenient to form the upper end cap 20 by molding, and particularly plastic molding. Since the groove 24 for receiving the O-ring 23 is formed in the exterior of the upper end cap 20, the groove 24 can be formed as part of the molding process and does not need to be machined, as would be an interior groove. Therefore, the upper end cap 20 can be formed quite economically.

The lower end cap 25 disposed at the end of the filter body 11 remote from the head 60 is not always necessary but is frequently desirable as a means to seal off the lower end of the filter body 11, to protect or immobilize the lower end of the filter body 11, or to connect the lower end of the filter cartridge 10 to another member, such as another filter cartridge 10. The illustrated lower end cap 25 is a blind end cap, but it may instead be an open end cap when, for example, the filter cartridge 10 is to be connected in series with another member or when the filter body 11 is of an axial flow type and it is desired to axially introduce fluid to be filtered through the lower end of the filter body 11.

When the bore 12 in the filter body 11 extends to the lower end surface of the filter body 11, the lower end cap 25 will usually be sealed to the filter body 11. Sealing may be performed by any of the various methods described with respect to the upper end cap 20.

Like the upper end cap 20, the lower end cap 25 can be made of any material compatible with the fluid being filtered and having a strength suitable for the functions which the lower end cap 25 is to perform, including but not being limited to both metals and plastics. In many cases, it is convenient to form the lower end cap 25 of a molded plastic.

The core 30 may have any structure which enables it to support the filter body 11 in the desired manner and to transport fluid between the head 60 of the housing 50 and the interior of the filter body 11. Frequently, the core 30 will be a tubular member having a hollow center and perforations, pores, or other openings in its periphery through which fluid can flow between the interior of the core 30 and the filter body 11, but the core 30 need not be hollow as long as it is capable of transporting fluid in a desired direction. For example, the core 30 may be a solid, porous member through which fluid can flow axially, or it may be a solid member having channels formed in its exterior surface for transporting fluid in the axial direction of the core 30. Frequently, the core 30 will be cylindrical, but other shapes may be employed, such as a shape with a polygonal or oval cross section, and the cross-sectional shape of the core 30 may vary along its length. The core 30 may be formed of any material compatible with the fluid being filtered and having the desired strength, including but not being limited to both metals and plastics. In the present embodiment, the core 30 comprises a perforated tube of a corrosion resistant metal, such as tin-plated cold-rolled steel.

The core 30 need not extend over the entire length of the filter body 11. Preferably, it extends over a sufficient region of the length of the filter body 11 to protect the filter body 11 from damage by radial forces. The upper end of the core 30 may but need not extend to the exterior of the filter cartridge 10. Similarly, the lower end of the core 30 may be disposed entirely within the filter cartridge 10, or if the lower end cap 25 is an open end cap, the core 30 may extend through the lower end cap 25 to its exterior. For example, a core 30 passing through the lower end cap 25 may be used to support a plurality of filter segments arranged end-to-end in series. Furthermore, if the lower end of the core 30 extends through the lower end cap 25, the core 30 may be used as a tie rod to prevent the filter cartridge 10 from becoming detached from the head 60 of the housing 50.

The lower end of the core 30 may be either open or closed, and it may contact

or be spaced from the lower end cap 25. For example, if it is desired that the core 30 resist upward axial forces applied to the filter cartridge 10, the lower end of the core 30 may abut against the inner surface of the lower end cap 25. In the present embodiment, the length of the core 30 is such that the lower end of the core 30 can abut against the upper inner surface of the lower end cap 25 without the upper end cap 20 abutting against the head 60 of the housing 50 so that when an upwards force is applied to the lower end cap 25, the force can be resisted by the core 30 rather than being applied to the filter body 11.

The illustrated core 30 comprises a single continuous tube, but it is also possible for the core 30 to be formed from a plurality of sections joined end-to-end in series.

If desired, the upper end of the core 30 may be secured to the head 60 of the housing 50 so as to remain attached to the head 60 when the filter cartridge 10 is removed from the filter housing 50. The core 30 may be secured to the head 60 in any convenient manner, either permanently, such as by welding, or detachably, such as by threaded engagement or a bayonet fit. In the illustrated embodiment, the upper end of the core 30 is retained between the inner periphery of a tubular fitting 66 of the head 60 and the outer periphery of a retaining ring 32 disposed in the fitting 66. The outer diameter of the retaining ring 32 is small enough for the retaining ring 32 to be readily inserted into the fitting 66 and abut against a horizontal ledge of the fitting 66. The outer diameter of the retaining ring 32 increases from the lower end to the upper end of the retaining ring 32. Before being installed on the head 60, the core 30 in an undeformed state has a uniform diameter over its entire length. To install the core 30 on the head 60, the upper end of the core 30, in its undeformed state, is disposed opposite the annular space between the outer periphery of the retaining ring 32 and the inner periphery of the fitting 66. An axial compressive force is then applied to the core 30 by a suitable mechanism, such as a hydraulic press, to force the upper end of the core 30 into the space. For example, the axial compressive force can be applied to the lower end of the core 30 while the fitting 66 is restrained against movement. As the core 30 enters the space, it is deformed (possibly elastically but usually plastically) by the expanding outer diameter of the retaining ring 32 so as to flare outwards and enter into a groove 68 extending around the inner periphery of the fitting 66. When the axial compressive force on the core

30 is released, the upper end of the core 30 is retained between the retaining ring 32 and the groove 68 and is thus secured to the fitting 66 so as to be able to resist both tensile and compressive axial forces applied to it. While securing the core 30 to the head 60 may simplify the installation and replacement of the filter cartridge 10 since there is no danger of the core 30 falling from the head 60 when the filter cartridge 10 is removed, it is also possible for the core 30 to loosely engage the head 60 or to be unconnected to the head 60 so that when the filter cartridge 10 is removed from the head 60, the core 30 can be removed with the filter cartridge 10. Having the core 30 readily detachable from the head 60 is convenient when there is insufficient clearance beneath the housing bowl 70 to enable the filter cartridge 10 to pass over the entire length of the core 30 with the core 30 still attached to the head 60.

The core 30 may be used to support the filter cartridge 10 in a variety of manners. For example, it may support the filter cartridge 10 against axial compressive force, against bending or torsional forces, or against radial forces. The outer diameter of the core 30 can be selected in accordance with the function it is desired that the core 30 perform. As stated above, if the core 30 is intended to reinforce the filter body 11 against radially inward forces, the outer surface of the core 30 is preferably in contact with or in close proximity to the inner periphery of the bore 12 of the filter body 11 so that radially inward deformation of the filter body 11 will be limited to a level which will not damage the filter body 11. On the other hand, if the purpose of the core 30 is simply to help position the filter cartridge 10 with respect to the filter housing 50 or to resist non-radial forces, the core 30 need not contact the inner periphery of the filter body 11 at any time.

The core 30 need not be sealed either to the filter cartridge 10 or to the head 60 since the seal between the upper end cap 20 and the head 60 prevents fluid from bypassing the filter body 11. The lack of a need for a seal simplifies the process of securing the core 30 to the head 60.

The filter cartridge 10 may include various components other than those shown in the drawings. For example, it may include a protective cage surrounding the filter body 11 and extending between the end caps 20, 25 for protecting the filter body 11 from crushing by external forces, for preventing the filter cartridge 10 from ballooning outwards when subjected to radially outward fluid pressures, or for providing the filter cartridge 10 as a whole with greater rigidity.

An example of a method of forming a filter cartridge according to the present invention is as follows. The illustrated filter cartridge 10 includes a filter body 11 formed from a multi-layer sheet-like composite containing a filter layer, two drainage layers each comprising an extruded polymeric mesh on the upstream and downstream sides of the filter layer, and a cushioning layer of a highly porous, abrasion resistant nonwoven fabric disposed between the filter layer and one or both of the drainage layers. The composite is pleated with conventional corrugating equipment to form parallel lengthwise pleats, and the pleated composite is formed into a tubular shape and sealed in a conventional manner along the lengthwise edges of the composite to form a lengthwise side seal. After the side seal is formed, a wrap member is wound helically around the exterior of the pleats in a plurality of turns with a helical gap between adjoining turns. The wrap member comprises a thin strip of a polymeric nonwoven fabric which is joined to the radially outer ends of the pleats by a plurality of beads of a hot melt adhesive extending along the length of the wrap member to maintain the spacing between adjoining pleats. The tension on the wrap member is controlled to give the filter body a desired inner diameter. Two polymeric end caps 20, 25 are then melt sealed to the lengthwise end surfaces of the filter body 11 over the ends of the wrap member, and a polymeric O-ring 23 is mounted in a circumferentially-extending groove 24 in the upper end cap 20 to complete the filter cartridge 10.

A housing for use with the filter cartridge 10 may have any structure which enables it to guide fluid to be treated through the filter cartridge 10 in a desired direction. The illustrated housing 50 is designed to house a single filter cartridge 10, but it may instead have a structure enabling it to house a plurality of filter cartridges 10. The bowl 70 of the housing 50 may be detachably connected to the head 60 in any suitable fluid-tight manner, such as by threaded engagement between external threads formed at the upper end of the bowl 70 and internal threads formed on the head 60. The illustrated bowl 70 is formed with flats 72 on its outer surface which make it easier to grasp and turn the bowl 70 when it is being connected to or disconnected from the head 60. The bowl 70 may also be equipped with a drain plug 71 in its lower portion. The head 60 includes the above-described hollow fitting 66 for receiving the neck 22 of the upper end cap 20 of the filter cartridge 10. The fitting 66 may have any shape which enables its inner surface to seal against the

sealing ring 23 on the upper end cap 20. In the present embodiment, the fitting 66 has a cylindrical inner surface 67 for sealing against the sealing ring 23, but if the neck 22 of the upper end cap 20 is noncylindrical, the inner surface 67 may have a similar noncylindrical shape corresponding to that of the neck 22. The fitting 66 in the present embodiment is integrally formed with other portions of the head 60, but it may be a separately formed member, such as a detachable member to enable the head 60 to be used with different types of filter cartridges by installing a fitting 66 having a size and shape corresponding to the filter cartridge which is to be employed. The head 60 also includes an inlet 61 and an outlet 62 which open onto exterior surfaces of the head 60. A connecting bore 63 is formed through the head 60 between the inlet 61 and the outlet 62. The inlet 61 communicates through a passage 64 with the region within the bowl 70 surrounding the filter cartridge 10, while the outlet 62 communicates with the interior of the fitting 66 through the connecting bore 63. A spring-loaded bypass valve 80, which may be of conventional design, may be installed in the connecting bore 63 to fluidly interconnect the inlet 61 and the outlet 62 when the pressure differential between the inlet 61 and the outlet 62 reaches a certain level, such as a level which could damage the filter cartridge 10 or impose an excessive load on pumping equipment forcing fluid through the filter cartridge 10. The illustrated bypass valve 80 includes a poppet 81 which can move into and out of sealing contact with a hollow valve seat 82 disposed in the connecting bore 63. The poppet 81 is urged into sealing contact with the valve seat 82 by a biasing spring 83 disposed in a cage 84 having one or more openings 84a in its periphery through which fluid can flow between the interior and exterior of the cage 84. One side of the poppet 81 (the right side in Figure 1) is exposed to the fluid pressure at the inlet 61, while the opposite side of the poppet 81 is exposed to the fluid pressure at the outlet 62. During normal operating conditions, the difference between the fluid pressures at the inlet 61 and the outlet 62 is such that the poppet 81 is closed so that all fluid which enters the inlet 61 is directed into the bowl 70 through passage 64 to be filtered by the filter cartridge 10. As filtering proceeds and the filter cartridge 10 accumulates particles present in the fluid being filtered, the pressure differential between the inlet 61 and the outlet 62 increases. When the pressure at the inlet 61 exceeds the pressure at the outlet 62 by more than a predetermined value indicating that the filter body 11 has become loaded and needs replacement or cleaning, the

poppet 81 opens against the biasing force of the spring 83 and allows fluid to bypass the filter cartridge 10 by flowing from the inlet 61 to the outlet 62 through the connecting bore 63. The opening of the poppet 81 equalizes the pressures at the inlet 61 and the outlet 62 and prevents the filter cartridge 10 or pumping equipment from being damaged by too high a differential pressure. Although not shown, the head 60 may also contain a differential pressure indicator which is subjected to the inlet and outlet pressures and which produces an indication, such as an electrical output signal or a visual indication, when the differential pressure across the filter cartridge 10 reaches a predetermined level, such as a level causing the bypass valve 80 to open.

The head 60 may also include an air vent 65 communicating between the interior and exterior of the head 60. The air vent 65 can be used to permit air or other gas to escape from the interior of the head 60 when the housing 50 is being filled with fluid prior to the start of filtering operation. After venting, the air vent 65 can be closed with an unillustrated plug or other suitable member. The air vent 65 is normally kept closed during operation of the filter arrangement.

Although not shown, the head 60 of the housing 50 may include a check valve disposed between the upper end of the filter cartridge 10 and the outlet 62 to prevent fluid from flowing from the outlet 62 into the core 30 when the filter cartridge 10 is being removed from the housing 50.

When it is desired to replace the filter cartridge 10, the bowl 70 is unscrewed from the head 60 of the housing 50, and the filter cartridge 10 is pulled downwards along the core 30 until it is free of the core 30. The filter cartridge 10 can then be cleaned, discarded, incinerated, or otherwise disposed of in a suitable manner. A replacement filter cartridge 10 is then slid upwards over the core 30 until the O-ring 23 on the upper end cap 20 of the replacement filter cartridge 10 enters into the fitting 66 and seals against the inner surface 67 of the fitting 66. The bowl 70 can then be reconnected to the head 50 to enable filtering operation to resume.

Figure 2 is a cross-sectional elevation of another embodiment of a filter arrangement according to the present invention. The filter cartridge 10 in this embodiment is identical to that of the previous embodiment, the principle difference between this embodiment and the previous embodiment being the structure of the housing 100 of the filter arrangement. The housing 100 includes a head 110 and a bowl 140 detachably mounted on the head 110 for receiving the filter cartridge 10.

The head 110 includes an inlet 111 which opens onto a side surface of the exterior of the head 110 and an outlet 114 which opens onto a top surface of the head 110. The inlet 111 and the outlet 114 both communicate with an inlet chamber 112 which opens onto the bottom surface of the head 110. The bowl 140 of the housing 100 can be connected to the bottom surface of the head 110 in any suitable fluid-tight manner so as to communicate with the inlet chamber 112. For example, the lower end of the inlet chamber 112 may be formed with internal threads 113 for threaded engagement with external threads formed on the upper end of the bowl 140. A hollow fitting 120 for receiving the upper end cap 20 of the filter cartridge 10 is mounted in a connecting bore 115 connecting the inlet chamber 112 and the outlet 114. The fitting 120 includes a cylindrical base 121 which is screwed into internal threads formed in the connecting bore 115 and a tubular portion 123 which extends away from the base 121 into the inlet chamber 112. The tubular portion 123 has a cylindrical inner surface 124 which receives the neck 22 of the upper end cap 20 of the filter cartridge 10 and is in sealing contact with the sealing ring 23 mounted on the neck 22. The core 30 in the present embodiment is secured to the interior of the tubular portion 123, but as in the previous embodiment, the core 30 may be loosely received by the head 110, or it may be unconnected to the head 110. In the present embodiment, the upper end of the core 30 is held between a groove 125 formed around the inner periphery of the tubular portion 123 of the fitting 120 and the outer surface of a retaining ring 136 which performs a function similar to that performed by the retaining ring 32 of Figure 1. The upper end of the tubular portion 123 of the fitting 120 also contains a bypass valve 130. The bypass valve 130 includes a hollow poppet 131 which is slidably received in the tubular portion 123 and can slide between a closed position, shown in Figure 2, in which the upper end of the poppet 131 is in sealing contact with an annular valve seat 133 disposed at the upper end of the connecting bore 115, and an open position in which the poppet 131 is moved downward from the closed position so that the upper end of the poppet 131 is spaced from the valve seat 133 and fluid can flow between the poppet 131 and the valve seat 133 through a central opening in the valve seat 133 and into the outlet 114. A sealing member 134 such as a sealing ring may be provided to form a seal between the valve seat 133 and the head 110. The poppet 131 is biased toward its closed position by a biasing spring 135, one end of which contacts the upper surface of the

retaining ring 136, which also functions as a spring seat, and the other end of which is pressed against a ledge formed on the interior of the poppet 131. A sealing ring 132 may be mounted on the exterior of the poppet 131 to form a sliding seal between the poppet 131 and the tubular portion 123 of the fitting 120. The interior of the poppet 131 is exposed to fluid at the pressure of the outlet 114, and the exterior surface of the poppet 131 above the sealing ring 132 is exposed to the pressure in the inlet chamber 112 through one or more passages 122 formed in the base 121 of the fitting 120 and extending between the side of the base 121 opposing the inlet chamber 112 and the side of the base 121 opposing the valve seat 133. The spring force of the biasing spring 135 is selected such that under normal filtering conditions in which the differential pressure across the filter cartridge 10 is acceptable, the poppet 131 will remain closed so that fluid can flow between the inlet chamber 112 and the outlet 114 only by passing through the filter cartridge 10. However, when the filter cartridge 10 becomes loaded with particles in the fluid being filtered and the differential pressure between the inlet 111 and outlet 114 reaches a predetermined level, the poppet 131 will open by moving downward away from the valve seat 133, thereby allowing fluid to bypass the filter cartridge 10 and to flow from the inlet chamber 112 into the outlet 114 through the bores 122 in the base 121. When the poppet 131 is moved to its open position, the lower end of the poppet 131 may seat on an annular ledge 137 of the retaining ring 136 at the lower end of the biasing spring 135.

An unillustrated differential pressure indicator for sensing the pressure differential between the inlet chamber 112 and the outlet 114 may be inserted into a chamber 116 opening onto the exterior of the housing 100. The chamber 116 communicates with the inlet chamber 112 through a first passage 117 and with the outlet 114 through a second passage 118 so that a differential pressure indicator disposed in the chamber 116 can be exposed to both the inlet and outlet pressures. The differential pressure indicator may be of any type which generates an indication, such as an electrical output signal or a visual indication, when the pressure in the inlet chamber 112 exceeds the pressure in the outlet 114 by more than a predetermined amount, indicating that the filter cartridge 10 needs replacement.

As stated above, the core 30 does not need to be permanently connected to a housing or other component of a fluid system. Figure 3 illustrates another embodiment of a filter arrangement according to the present invention which is

identical to the embodiment of Figure 1 except that the core 30 is loosely received in the fitting 66 of the head 60 of the housing 50 rather than being secured to it so that the core 30 and the filter cartridge 10 can be installed on and removed from the head 60 at the same time.

What is claimed is:

1. A filter cartridge for use with a detachable core comprising:

a filter body having a filter medium and a bore communicating with a first end surface of the filter body;

a first end cap adjoining the first end surface of the filter body and having a sealing surface formed on an exterior thereof for forming a seal between the first end cap and a portion of a fluid system, the filter cartridge being without a core.

2. A filter cartridge as claimed in claim 1 including a sealing member mounted on the sealing surface.

3. A filter cartridge as claimed in claim 2 wherein the sealing surface is on an outer periphery of the first end cap.

4. A filter cartridge as claimed in claim 3 wherein the sealing member comprises a sealing ring mounted in a groove on the exterior of the first end cap.

5. A filter cartridge as claimed in claim 4 wherein the first end cap and the groove in the first end cap are formed by molding.

6. A filter cartridge as claimed in claim 5 wherein the first end cap comprises a molded plastic.

7. A filter cartridge as claimed in claim 1 wherein the bore of the filter body has a minimum diameter smaller than a minimum inner diameter of the first end cap.

8. A filter cartridge as claimed in claim 1 wherein the filter body comprises lengthwise pleats.

9. A filter cartridge as claimed in claim 1 including a second end cap adjoining a second end surface of the filter body.

10. A filter arrangement comprising:

a housing including an inlet, an outlet, and a hollow fitting communicating with one of the inlet and the outlet;

a filter cartridge without a core disposed in the housing and comprising a filter body having a filter medium, the filter body having a bore communicating with a first end surface of the filter body, and a first end cap adjoining the first end surface of the filter body and sealed on an exterior surface of the first end cap to the fitting; and

an elongated core capable of transporting a fluid in an axial direction thereof detachably received in the bore of the filter cartridge.

11. A filter arrangement as claimed in claim 10 wherein the core is secured to the housing.

12. A filter arrangement as claimed in claim 10 wherein the core is detachable from the housing without damaging the core.

13. A filter arrangement as claimed in claim 10 wherein the core loosely engages the housing.

14. A filter arrangement as claimed in claim 10 wherein the core is not connected to the housing.

15. A filter arrangement as claimed in claim 10 wherein the core is not sealed to the housing.

16. A filter arrangement as claimed in claim 10 wherein the core is not sealed to the first end cap.

17. A filter arrangement as claimed in claim 10 wherein the core extends through the first end cap.

18. A filter arrangement as claimed in claim 10 including a sealing member mounted on the exterior surface of the first end cap and forming a seal between the first end cap and the fitting.

19. A filter arrangement as claimed in claim 18 wherein the sealing member comprises a sealing ring mounted on an outer periphery of the first end cap.

20. A filter arrangement as claimed in claim 19 wherein the first end cap includes a base sealed to the end surface of the filter body and a hollow neck extending from the base into the fitting, the sealing ring being mounted on the neck.

21. A filter arrangement as claimed in claim 20 wherein the sealing ring is mounted in a groove formed in an exterior of the neck.

22. A filter arrangement as claimed in claim 21 wherein the first end cap comprises a molded polymer and the groove is formed in the first end cap by molding.

23. A filter arrangement as claimed in claim 10 including a second end cap sealed to a second end of the filter body.

24. A filter arrangement as claimed in claim 23 wherein the second end cap is a blind end cap and the core has an end opposing an inner surface of the second end cap.

25. A filter arrangement as claimed in claim 24 wherein the core is long enough to abut against the inner surface of the second end cap without the first end cap abutting against the fitting.

26. A filter arrangement as claimed in claim 10 including a ring disposed inside the fitting, the core being retained between an outer surface of the ring and an inner surface of the fitting.

27. A filter arrangement as claimed in claim 10 wherein the fitting is detachable from the housing.

28. A filter arrangement as claimed in claim 10 including a bypass valve associated with the housing and enabling fluid to flow between the inlet and the outlet without flowing through the filter cartridge when a difference between a pressure at the inlet and a pressure at the outlet is greater than a predetermined value.

29. A filter arrangement as claimed in claim 28 wherein the bypass valve is disposed in the fitting between the filter cartridge and the outlet.

30. A filter arrangement as claimed in claim 10 wherein the core engages the bore of the filter body with an interference fit.

31. A filter arrangement comprising:

a filter body having a filter medium and a bore communicating with a first end surface of the filter body;

a first end cap adjoining the first end surface of the filter body and having a bore and a sealing surface formed on an exterior thereof for forming a seal between the first end cap against an interior surface of a filter housing; and

a core slidably received within the bore of the filter body and having an outer diameter enabling the core to pass in a lengthwise direction through the bore in the first end cap.

32. A filter arrangement as claimed in claim 31 including a sealing member mounted on the sealing surface of the first end cap for sealing against an interior surface of a filter housing.

33. A filter arrangement as claimed in claim 31 wherein the core is not sealed to the first end cap.

34. A filter arrangement as claimed in claim 31 including a second end cap adjoining a second end of the filter body.

35. A filter arrangement as claimed in claim 34 wherein the core is long enough to abut against an interior surface of the second end cap while extending through the first end cap to an exterior of the filter cartridge.

36. A filter arrangement as claimed in claim 31 wherein the first end cap is sealed to a portion of a fluid system.

37. A filter arrangement as claimed in claim 36 wherein the first end cap is sealed to an interior of a housing.

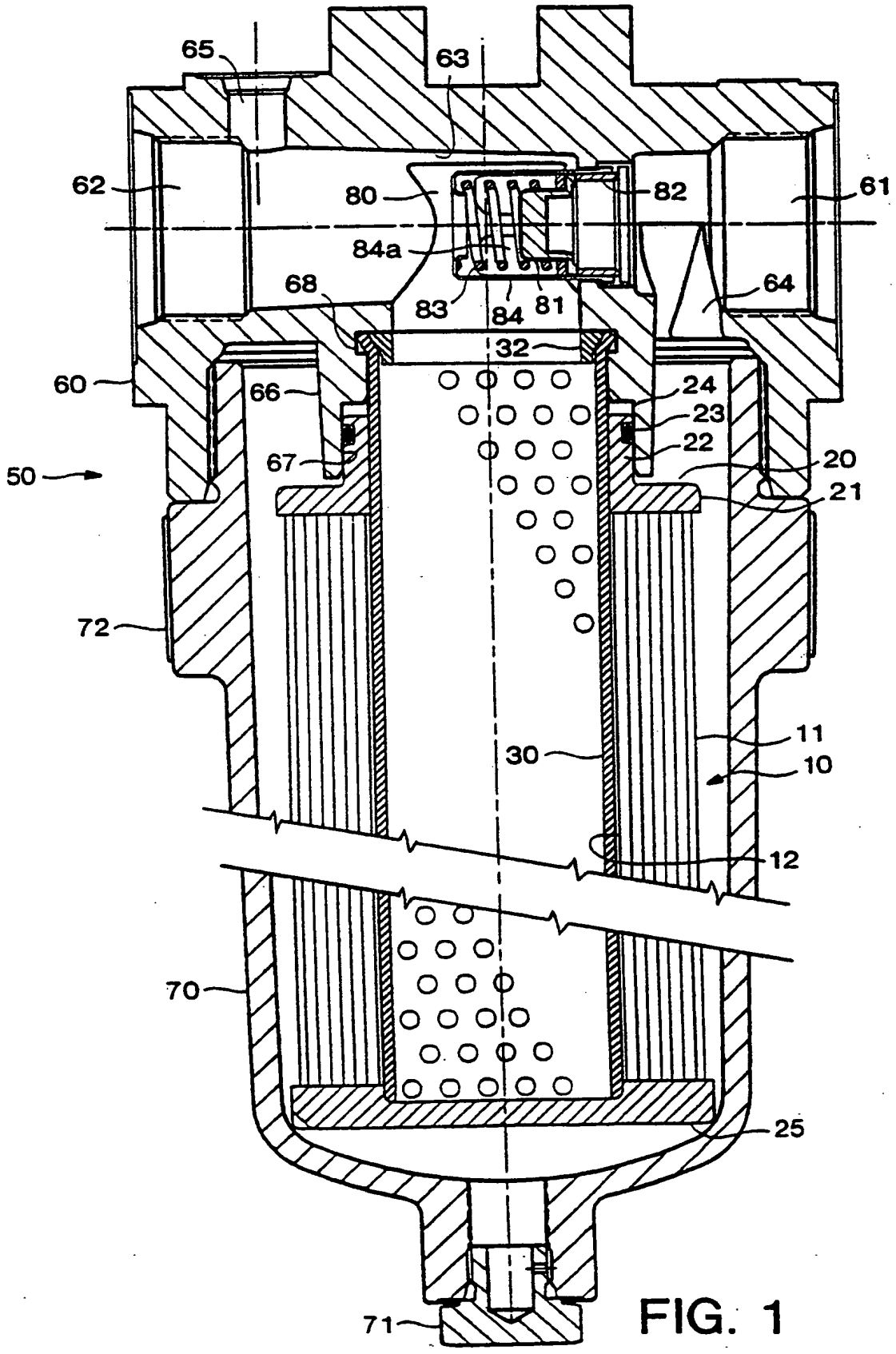

FIG. 1

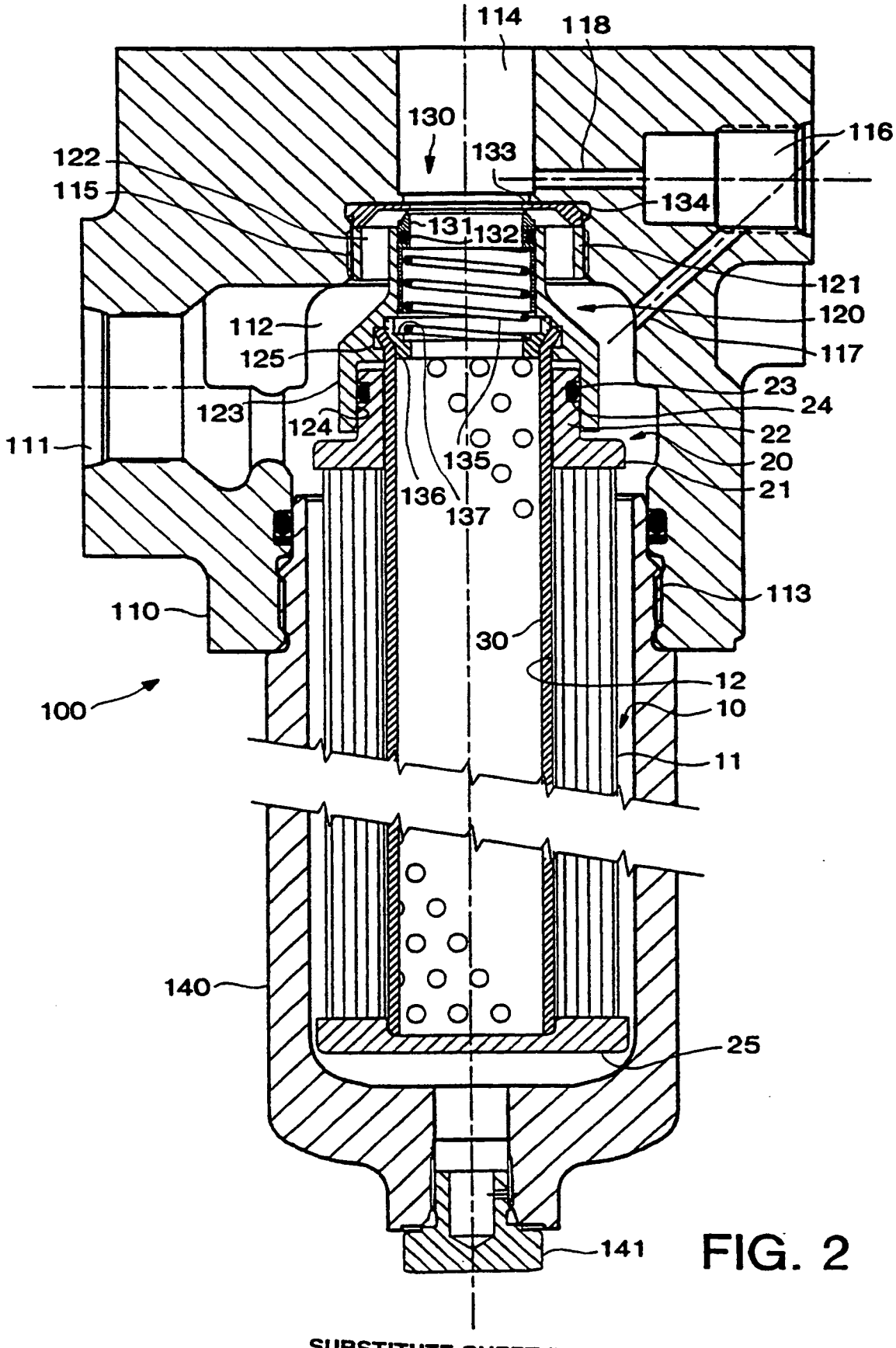

FIG. 2

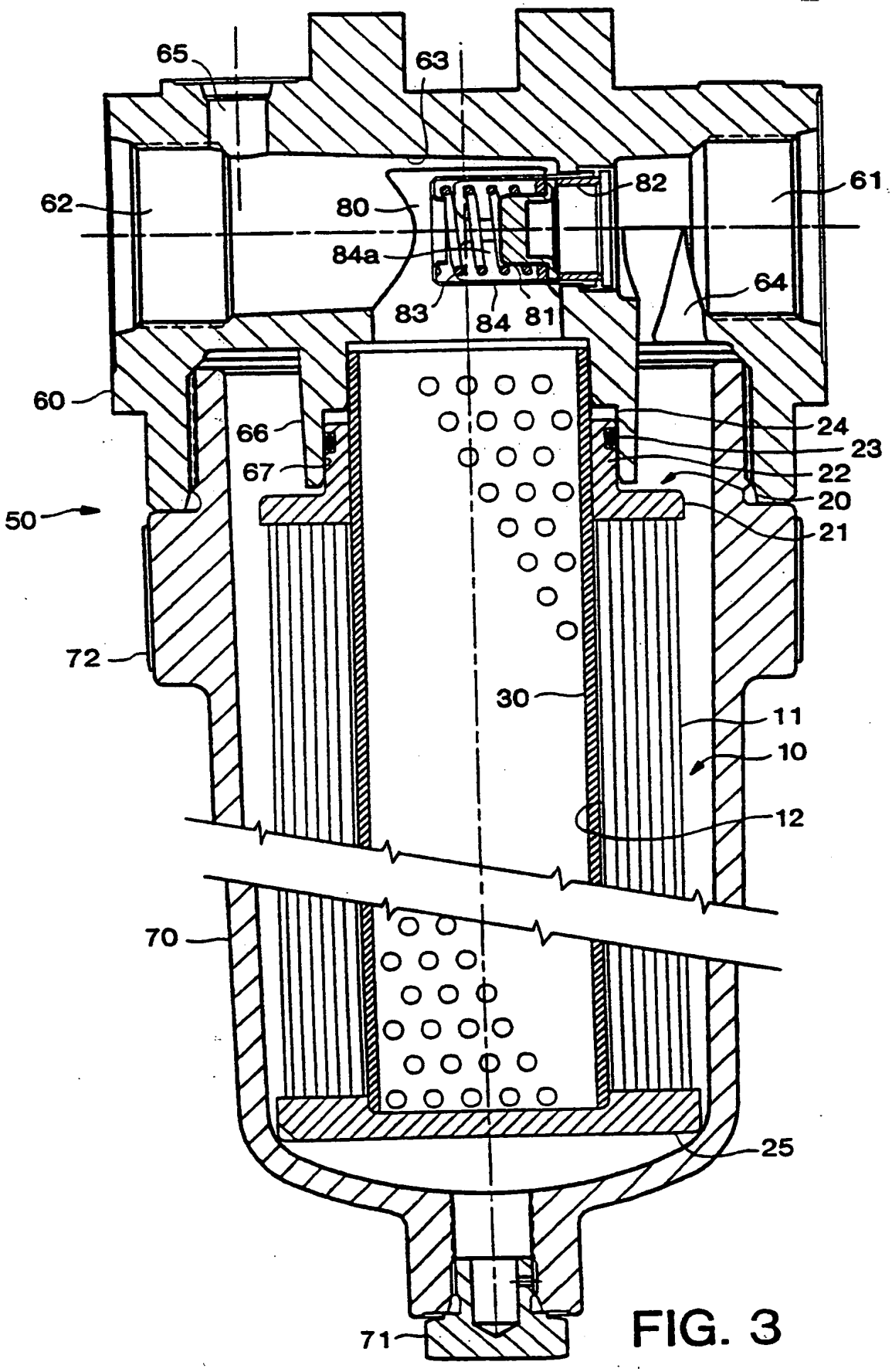

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/06012

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :B01D 46/24
US CL :55/312,486,498,502
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 55/312,486,498,502,309,482,487,490,510,503,505,507

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US 5,685,985 A (BROWN et al.) 11 NOVEMBER 1997, Figs. 1-2, col. 4 line 1-col. 5 line 60.	1-27,29-37
X ----- Y	US 5,476,585 A (MILLS) 19 DECEMBER 1995, Figs. 1-2, col. 2 lines 30-60.	1-27,29-37 ---------- 28
Y	US 2,096,484 A (FARMER) 19 OCTOBER 1937, Fig. 1, col. 1 line 30-col. 2 line 50.	28
A	US 3,384,241 A (NOSTRAND) 21 MAY 1968.	1-27,29-37
A	US 4,243,397 A (TOKAR et al.) 06 JANUARY 1981.	1-27, 29-37
A	US 5,015,375 A (FLECK) 14 MAY 1991.	1-27,29-37

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
14 MAY 1998

Date of mailing of the international search report
23 JUN 1998

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/06012

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,211,846 A (KOTT et al.) 18 MAY 1993.	1-27,29-37